

# Iron Deficiency Anemia, Active Component, U.S. Armed Forces, 2002-2011

Iron deficiency anemia (IDA) is the most common cause of anemia in the United States, and it particularly affects women of child-bearing age and black, non-Hispanic race/ethnicity. During the surveillance period there were 10,157 incident ("new") cases of IDA among active component service members; the overall incidence rate was 7.1 per 10,000 person-years. The annual incidence rates increased in both males and females during the period. Rates of IDA were higher among service members who were female, in the youngest (<20 years) and oldest age groups (40+ years), and of black, non-Hispanic race/ethnicity. Most (85.3%) incident cases had no additional encounters for IDA one year or more after their incident encounter. The most common diagnoses associated with IDA during the one year before or after the incidence dates of IDA were "gastrointestinal hemorrhage" (12.4%) in males and "disorders of menstruation and other abnormal bleeding from the female genital tract" (15.2%) in females. Because IDA can adversely affect physical work capacity and cognitive functioning, health care providers should be alert to IDA among service members, particularly servicewomen, before intensive training activities and deployment.

Iron deficiency (ID) is the most common micronutrient deficiency, affecting up to 2 billion people worldwide.<sup>1</sup> Iron deficiency may range from mild depletion of the body's iron stores to a substantial iron deficit resulting in iron deficiency anemia (IDA). Iron is an essential part of hemoglobin, the substance in red blood cells (RBCs) that carries oxygen from the lungs to the rest of the body. In the face of serious iron deficiency, the bone marrow produces fewer RBCs than normal (anemia), and the RBCs contain less hemoglobin than usual. The net effect is impairment of oxygen transport to cells throughout the body. An individual with IDA may have no symptoms or mild symptoms that worsen as IDA progresses. Common symptoms include fatigue, weakness, cold hands and feet, shortness of breath, headache, dizziness, irritability, and glossitis.<sup>2</sup> In general, treatment of IDA is directed at the underlying cause of the disease but also typically includes the use of iron supplementation and dietary changes to increase iron intake and absorption.

IDA is the leading cause of anemia in the United States and is most common

among women of child-bearing age and black, non-Hispanic race/ethnicity.<sup>3,4</sup> In premenopausal women, menstrual blood loss, particularly in women with heavy, long, or frequent menstrual periods, and pregnancy-related iron loss account for most IDA diagnoses.<sup>2,3</sup> Occult bleeding from the gastrointestinal tract (e.g., from ulcers, infections, or cancers of the digestive system) is the leading cause of IDA in men and postmenopausal women.<sup>5</sup> Other possible factors in IDA include blood loss from acute trauma or chronic conditions such as uterine leiomyomas, as well as inadequate body iron stores due to an iron poor diet or impaired absorption of ingested iron.

Among members of the U.S. Armed Forces, IDA is more often found in women although both young men and women engaged in strenuous physical activity (e.g., during basic training or operational deployments) are at risk for depletion of iron stores.<sup>6,7</sup> Maintaining optimal iron status among military personnel is important as IDA can have health and military readiness implications. If not detected and treated, IDA can cause reduced physical work capacity, poor cognitive functioning,

and inadequate immune response.<sup>8-10</sup> As such, the condition may impact situations that require maximal cognitive and physical performance such as training and combat operations.<sup>11</sup>

This report summarizes the numbers, rates, and trends of incident ("new"), recurrent, and chronic cases of IDA and associated conditions among active component servicemen and women.

## METHODS

The surveillance period was 1 January 2002 to 31 December 2011. The surveillance population included all U.S. service members of the Army, Navy, Air Force, Marine Corps, and Coast Guard who served in the active component during the surveillance period. Cases were identified from standardized records of all hospitalizations and outpatient medical encounters during the surveillance period in fixed (e.g., not deployed, at sea) military and nonmilitary (purchased care) medical facilities.

For this analysis, a case was defined by a diagnosis with an International Classification of Diseases, Clinical Modification (ICD-9-CM) code of 280.x "iron deficiency anemia" in the first or second diagnostic position on a record of: 1) one inpatient encounter; 2) two outpatient encounters within 365 days of each other; or 3) two outpatient encounters, one with a diagnosis of ICD-9-CM: 281.9 or 285.9 ("unspecified deficiency anemia" or "anemia, unspecified") followed by an encounter with a specific iron deficiency anemia diagnosis within 365 days. Individuals with pregnancy-related anemia (ICD-9-CM: 648.2x) were excluded from the analysis if their history included this diagnosis within the preceding two years.

Each affected service member could be considered an incident ("new") case only once during the surveillance period. The incidence date was considered to be the date of the first medical encounter that included a diagnosis of anemia. Incident

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14. ABSTRACT <p><b>Iron deficiency anemia (IDA) is the most common cause of anemia in the United States, and it particularly affects women of child-bearing age and black, non-Hispanic race/ethnicity. During the surveillance period there were 10,157 incident (?new?) cases of IDA among active component service members the overall incidence rate was 7.1 per 10,000 person-years. The annual incidence rates increased in both males and females during the period. Rates of IDA were higher among service members who were female, in the youngest (&lt;20 years) and oldest age groups (40+ years), and of black, non-Hispanic race/ethnicity. Most (85.3%) incident cases had no additional encounters for IDA one year or more after their incident encounter. The most common diagnoses associated with IDA during the one year before or after the incidence dates of IDA were ?gastrointestinal hemorrhage? (12.4%) in males and ?disorders of menstruation and other abnormal bleeding from the female genital tract? (15.2%) in females. Because IDA can adversely affect physical work capacity and cognitive functioning, health care providers should be alert to IDA among service members, particularly servicewomen, before intensive training activities and deployment.</b></p>				
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cases were then stratified into three mutually exclusive categories: 1) a “one time” case if an individual met the criteria for an incident IDA case but had no subsequent encounters for IDA during the remainder of the surveillance period; 2) a “recurrent case” if an incident case had just one additional IDA encounter 365 days or more after the incidence date; or 3) a “chronic case” if there were two or more additional encounters 365 days or more after the incidence date and those encounters were separated by 365 days or more. An individual was counted as either a “one time,”

“recurrent,” or “chronic” case once during the surveillance period.

The medical records of anemia cases were queried to identify “associated conditions” (**Table 1**) which may have contributed to the development of the anemia. Associated conditions were defined as those occurring within 365 days before or after the incident diagnosis of IDA. Each such associated diagnosis was defined by an ICD-9-CM code of interest recorded in either of the first two diagnostic positions during a single inpatient encounter or during two outpatient encounters separated by fewer than 365 days.

## RESULTS

### Incident (“new”) cases

During 2002 to 2011, there were 10,157 incident cases (“new cases”) of iron deficiency anemia among active component service members. The incidence rate was 7.1 per 10,000 person-years (p-yrs) (**Table 2**).

A majority of incident cases occurred in females (60%; n=6,052); the overall incidence rate was 7.8 times higher in females (29.5 per 10,000 p-yrs) than among males

**TABLE 1.** Conditions possibly associated with iron deficiency anemia

Infectious Diseases	
126.x	Ancylostomiasis/necatoriasis
Neoplasms	
150.x-154.x	Malignant neoplasm of selected digestive organs
174.x-175.x	Malignant neoplasm of breast (female and male)
218.x	Uterine leiomyoma
Diseases of the blood/blood-forming organs	
281-289	All diseases of blood except 280 (iron deficiency anemia)
Diseases of the circulatory system	
455.x	Hemorrhoids
Diseases of the digestive system	
530.x	Diseases of the esophagus
531.x-534.x	Ulcer of the digestive tract
535.x-558.x	Gastritis and colitis
562.x	Diverticula of intestine
578.x	Gastrointestinal hemorrhage
Diseases of the genitourinary system	
585.x	Chronic kidney disease
626.x	Disorders of menstruation/other abnormal bleeding
627.0	Premenopausal menorrhagia
627.1	Postmenopausal bleeding
Symptoms, signs, and ill-defined conditions	
780.2	Syncope and collapse
780.4	Dizziness and giddiness
780.79	Other malaise and fatigue
Injury and poisoning	
800.x-829.x	Fractures
860.x-869.x	Internal injury of the thorax, abdomen, and pelvis
870.x-897.x	Open wounds
900.x-904.x	Injury to blood vessels
940.x-949.x	Burns
958.x-959.x	Tramatic complications/unspecified injuries

**TABLE 2.** Number and rates of iron deficiency anemia by case type, active component, U.S. Armed Forces, 2002-2011

	Incident cases <sup>a</sup>			One time cases <sup>b</sup>			Recurrent cases <sup>c</sup>			Chronic cases <sup>d</sup>		
	No	Rate <sup>e</sup>	IRR	No	Rate <sup>e</sup>	% <sup>f</sup>	No	Rate <sup>e</sup>	% <sup>f</sup>	No	Rate <sup>e</sup>	% <sup>f</sup>
Total	10,157	7.1	.	8,668	6.7	85.3	623	0.5	6.1	866	0.7	8.5
Sex												
Female	6,052	29.5	8.8	4,962	26.6	82.0	449	2.4	7.4	641	3.4	10.6
Male	4,105	3.4	ref	3,706	3.4	90.3	174	0.2	4.2	225	0.2	5.5
Age group												
< 20	2,258	11.8	2.6	2,041	12.1	90.4	32	0.2	1.4	53	0.3	2.3
20-29	3,180	4.5	ref	2,767	4.3	87.0	215	0.3	6.8	254	0.4	8.0
30-39	2,613	6.8	1.5	2,070	6.0	79.2	182	0.5	7.0	315	0.9	12.1
40+	2,106	13.9	3.1	1,790	13.1	85.0	194	1.4	9.2	244	1.8	11.6
Female age group												
< 20	1,636	53.0	3.1	1,455	53.8	88.9	26	1.0	1.6	41	1.5	2.5
20-29	1,830	16.9	ref	1,535	15.6	83.9	160	1.6	8.7	192	2.0	10.5
30-39	1,514	31.2	1.8	1,120	25.3	74.0	133	3.0	8.8	229	5.2	15.1
40+	1,072	59.3	3.5	852	50.5	79.5	130	7.7	12.1	179	10.6	16.7
Male age group												
< 20	622	3.9	1.7	586	4.1	94.2	6	0.0	1.0	12	0.1	1.9
20-29	1,350	2.3	ref	1,232	2.3	91.3	55	0.1	4.1	62	0.1	4.6
30-39	1,099	3.3	1.5	950	3.2	86.4	49	0.2	4.5	86	0.3	7.8
40+	1,034	7.8	3.4	938	7.8	90.7	64	0.5	6.2	65	0.5	6.3
Race/ethnicity												
White, non-Hispanic	4,029	4.5	ref	3,588	4.4	89.1	196	0.2	4.9	245	0.3	6.1
Black, non-Hispanic	4,273	17.7	4.0	3,470	16.1	81.2	314	1.5	7.3	489	2.3	11.4
Hispanic	879	5.9	1.3	773	5.7	87.9	49	0.4	5.6	57	0.4	6.5
Asian/Pacific Islander	341	6.0	1.4	295	5.8	86.5	26	0.5	7.6	20	0.4	5.9
Other	635	8.0	1.8	542	7.6	85.4	38	0.5	6.0	55	0.8	8.7
Service												
Army	3,982	7.8	2.5	3,384	7.2	85.0	250	0.5	6.3	350	0.7	8.8
Navy	2,453	7.1	2.3	2,147	7.0	87.5	119	0.4	4.9	186	0.6	7.6
Air Force	2,826	8.2	2.7	2,339	7.6	82.8	217	0.7	7.7	269	0.9	9.5
Marine Corps	575	3.1	ref	522	3.1	90.8	16	0.1	2.8	37	0.2	6.4
Coast Guard	321	8.0	2.6	276	7.6	86.0	21	0.6	6.5	24	0.7	7.5

<sup>a</sup>A service member was an incident (“new”) case once per surveillance period

<sup>b</sup>One time case: no follow-up encounters 365 days or more after their incident encounter

<sup>c</sup>Recurrent case: one follow-up encounter 365 days or more after their incident encounter

<sup>d</sup>Chronic case: two or more follow-up encounters 365 days or more after their incident encounter

<sup>e</sup>Rate per 10,000 p-yrs

<sup>f</sup>Percentage of incident cases

(3.4 per 10,000 p-yrs). Females in the youngest (<20 years) and oldest ( $\geq$ 40 years) age groups and males in the oldest age group had the highest rates of IDA compared to their respective gender and age groups. Black, non-Hispanic service members had a rate that was almost 4 times that of white, non-Hispanic counterparts. Among the services, the overall incidence rate was lowest in the Marine Corps (3.1 per 10,000 p-yrs); rates among the remaining services (range 7.1 to 8.2 per 10,000 p-yrs) were similar (Table 2).

Among females, the incidence rates increased from 19.4 per 10,000 p-yrs in 2002 (n=409) to 37.2 per 10,000 p-yrs in 2010 (n=749) and then decreased to 30.4 per 10,000 p-yrs in 2011 (n=631) (Figure 1a). Among males, the rates increased from 2.3 per 10,000 p-yrs in 2002 (n=275) to 4.4 per 10,000 p-yrs in 2009 (n=551), then decreased to 3.7 and 3.6 per 10,000 p-yrs in 2010 and 2011, respectively (Figure 1b).

When stratified by age group, gender, and race/ethnicity, incidence rates were highest among female, black, non-Hispanic service members in the youngest and oldest age groups (102.5 and 109.5 per 10,000 p-yrs, respectively) (Figure 2a). Among males, black, non-Hispanic service members in the oldest age group had the highest incidence rate (15.0 per 10,000 p-yrs) (Figure 2b).

### One time cases

Of all incident cases, 85.3 percent (n=8,668) were one time cases, i.e., had no follow-up encounters for IDA after the case-defining year of diagnosis (Table 2). Compared to females, a greater proportion of incident male IDA cases were one time cases (males: 90%, n=3,706; females: 82%, n=4,962).

### Recurrent/chronic cases

Of all incident cases, 6.1 percent (n=623) were considered recurrent cases, i.e., had one IDA-related encounter 365 days or more after the first incident case encounter; 8.5 percent (n=866) were considered chronic cases, i.e., had two or more IDA-related encounters 365 days or more after the incident case encounter (Table 2). Recurrent/chronic cases had demographic characteristics similar to incident cases. Among all incident cases, greater proportions of females were considered to have become recurrent (7.4% [n=449]) and chronic (10.6% [n=641]) cases compared to males (4.2% [n=174] and 5.5% [n=225], respectively).

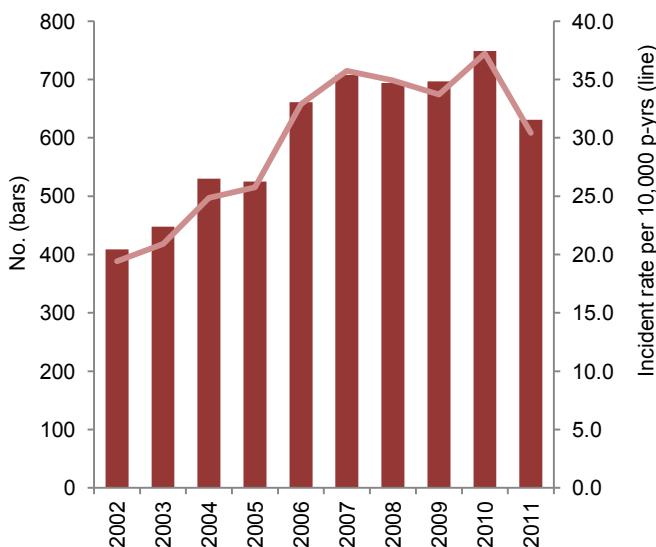
In both females and males, recurrent/chronic rates and proportions of incident cases increased with age (Table 2). Rates

of recurrent/chronic IDA were highest in black, non-Hispanic females (1.5 and 2.3 per 10,000 p-yrs, respectively) compared to other race/ethnicities. When stratified by age group, gender, and race/ethnicity, recurrent/chronic rates were highest among the oldest ( $>$ 40 years), black, non-Hispanic females (11.5 and 11.5 per 10,000 p-yrs, respectively) (data not shown).

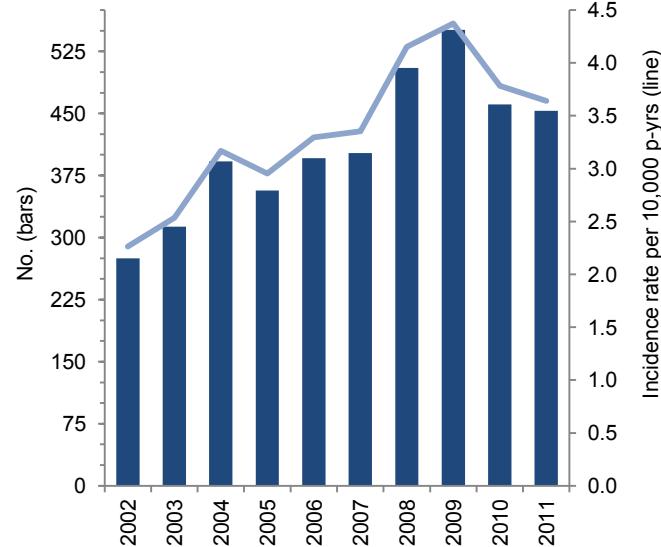
### Associated conditions

Of the incident cases identified during the period, more than half (55%; n=5,632) were diagnosed with a condition associated with IDA within either the one year before or the one year after the dates of the incident diagnoses of IDA. By gender, a greater proportion of males (65%) than females (49%) had an associated condition (data not shown). Among males, 40 percent of incident cases (n=1,637) had associated "diseases of the digestive system" (data not shown). Within this category, the subcategory contributing the greatest proportion of cases with an associated condition was "gastrointestinal hemorrhage" (12.4%; n=510). It is worth noting that 1.5 percent (n=63) of all males diagnosed with IDA (n=4,105) during the surveillance period were diagnosed with malignancies of the colon and/or rectal regions within a year of

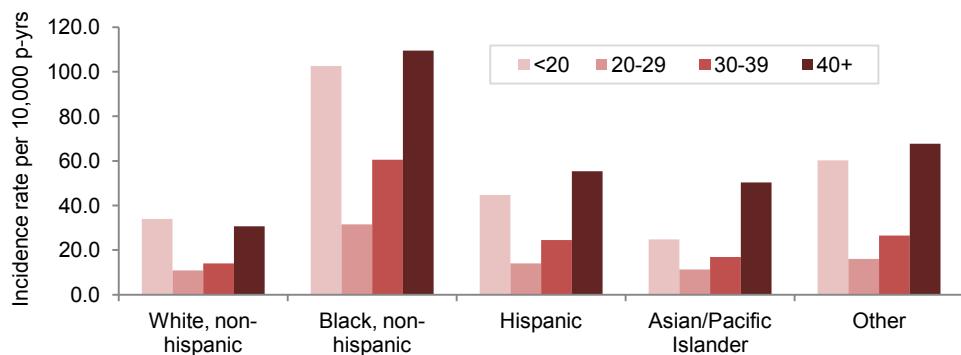
**FIGURE 1a.** Incident cases and incidence rate of iron deficiency anemia, active component females, U.S. Armed Forces, 2002-2011



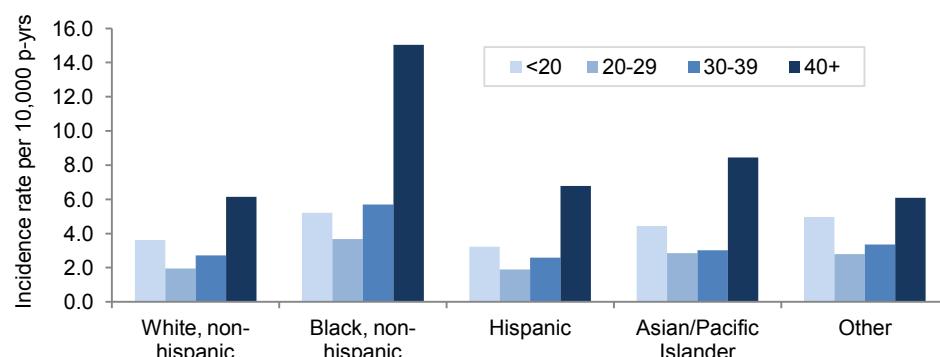
**FIGURE 1b.** Incident cases and incidence rate of iron deficiency anemia, active component males, U.S. Armed Forces, 2002-2011



**FIGURE 2a.** Incidence rates of iron deficiency anemia by age group and race/ethnicity, active component females, U.S. Armed Forces, 2002-2011



**FIGURE 2b.** Incidence rates of iron deficiency anemia by age group and race/ethnicity, active component males, U.S. Armed Forces, 2002-2011



their incident IDA diagnosis. Most (73%; n=46) of those malignancies were diagnosed during the year after the IDA incidence date.

Among females, the most often reported associated diagnoses were in three main categories: “diseases of the genitourinary system” (15.6%; n=943), “diseases of the digestive system” (15.4%; n=935), and “neoplasms” (8.9%; n=540). Within these categories, the subcategories contributing the greatest proportion of cases with an associated condition were “disorders of menstruation and other abnormal bleeding from the female genital tract” (15.2%; n=922); “other and unspecified noninfectious gastroenteritis and colitis” (8.0%; n=483); and “uterine leiomyoma” (8.5%; n=516), respectively (**data not shown**). Only 0.1 percent (n=8) of all women diagnosed with IDA were found to have colorectal cancer; most of them (n=6) were diagnosed after their IDA incidence date.

Associated diagnoses of serious injuries were documented for only 4.5 percent and 1.8 percent of all men and women with IDA diagnoses. Among the males, half of those injuries were recorded in the year after IDA was diagnosed. Among females, 59 percent were after the IDA diagnosis.

When examining recurrent/chronic cases 69 percent of males and 41 percent of females had an associated condition diagnosed within the one year before or after the incident diagnosis of IDA. Similar to all incident cases among males, “diseases of the digestive system” remained the category associated with the most recurrent and chronic IDA cases in men; however, in addition to “gastrointestinal hemorrhage” (12.5%; n=50), the other subcategories contributing the greatest proportion of cases with an associated condition were “diseases of the esophagus” (12.8%; n=51), and “gastitis and duodenitis” (12.0%; n=48) (**data not shown**).

Among females, the distributions of and proportions affected by associated conditions were similar between incident and recurrent/chronic conditions, i.e., “uterine leiomyoma,” “noninfectious gastroenteritis and colitis,” and “disorders of menstruation.”

#### EDITORIAL COMMENT

This report documents that, among U.S. service members, less than 1 in 1,000 males but 3 in 1,000 females were diagnosed with IDA during the surveillance period. Active component service members are similar to the U.S. civilian population in that rates of IDA are highest among black, non-Hispanic females. This finding is consistent with national studies and with research indicating lower mean hemoglobin concentrations in black, non-Hispanics compared to white, non-Hispanic counterparts even after adjustment for iron status.<sup>1,2</sup> A previous MSMR study documented that black, non-Hispanic women in the Armed Forces had much higher incidence rates of uterine leiomyomas, a diagnosis that affected 8.5 percent of women with IDA in this study.<sup>14</sup>

Of note, these data suggest that the rates of incident (“new”) IDA cases have been increasing among active component service members since 2002. Over the period of study, ongoing conflicts in Iraq and Afghanistan and the resultant increase in demanding physical training and repeated deployments may be associated with decrements in iron status among some military personnel. This study found, however, that traumatic injuries were infrequently associated with IDA, suggesting that severe blood loss and prolonged healing from possible combat wounds were not major contributors to the increase in rates of IDA. Previous studies of military recruits indicated that female personnel experience decreased iron status and diminished work capacity following training operations.<sup>9,15</sup> Increased training may also lead to lower body weight and changes in menstrual blood flow, both which have been associated with IDA.<sup>16,17</sup>

The increase in rates of IDA might also be attributable to dietary changes that led to inadequate daily intake of iron (recommended at 8mg/18mg/day for male and females, respectively, aged 19-50 years). Nutritional data collected during field training and in garrison demonstrate sub-optimal iron intake among female soldiers; therefore, women who are deployed may be significantly affected if inadequate iron intake occurs routinely or for extended periods.<sup>18</sup> Insufficient iron intake may be further compounded by the intense physical training and immune challenges common to field training and operational deployment.<sup>6</sup>

Furthermore, dietary habits (e.g., avoidance of red meat, vegetarianism) may fail to deliver sufficient amounts of iron to replace losses. High levels of consumption of coffee and tea and the excessive use of medications to inhibit stomach acid secretion may interfere with iron absorption.<sup>19,20</sup>

While studies examining IDA in military personnel are limited, these findings are consistent with a recent study of iron status, ID and IDA prevalence among military personnel deployed to Afghanistan that found ID in 1 percent and 6 percent and IDA in 0 percent and 2 percent of males and females, respectively.<sup>11</sup> This report shows that 18 percent of females and 10 percent of males diagnosed with IDA experience a recurrence (i.e., recurrent or chronic) of their condition. Given that menstrual blood loss is a strong determinant of iron status and that many women are unable to consume adequate iron to prevent this deficit, it is not surprising that, in susceptible individuals, the condition returns.<sup>17</sup>

In conclusion, for women in the military, reducing the incidence and prevalence of IDA is deserving of continued attention.

The findings of this report - along with those of others described here - suggest that health care providers should be alert to the possibility of IDA among servicewomen before intensive training activities and operational deployment and particularly for those with a history of IDA.<sup>9,11</sup> Furthermore, female service members should be made aware of the signs and symptoms of poor iron status and encouraged to optimize their dietary intake of iron, particularly during times of intense physical training or deployment.

*Acknowledgement: Susan Allen Ford, PA-C, MPH, Armed Forces Health Surveillance Center*

## REFERENCES

1. DeMaeyer E, Adiels-Tegman M. The prevalence of anemia in the world. *World Health Stat Q38:* 302-316, 1985.
2. Centers for Disease Control and Prevention. Iron and Iron Deficiency. <http://www.cdc.gov/nutrition/everyone/basics/vitamins/iron.html>
3. Centers for Disease Control and Prevention. Recommendations to prevent and control iron deficiency in the United States. *MMWR.*1998;47(RR-3):1-29.
4. Centers for Disease Control and Prevention. Iron deficiency - United States, 1999-2000. *MMWR.* 2002;51:897-899.
5. Zhu A, Kaneshiro M, Kaunitz JD. Evaluation and treatment of iron deficiency anemia: a gastroenterological perspective. *Dig Dis Sci.* 2010;55:548-559.
6. McClung, JP, Marchitelli, LJ, Friedl, KE and Young AJ. Prevalence of Iron Deficiency and Iron Deficiency Anemia among Three Populations of Female Military Personnel in the US Army. *J Am Coll Nutr.* February 2006;25 (1),64-69.
7. Moore RJ, Friedl KE, Tulley RT, Askew EW. Maintenance of iron status in healthy men during an extended period of stress and physical activity. *Am J Clin Nutr.* 1993;58(6):923-927.
8. Gardner G, Edgerton V, Senewiratne B, et al. Physical work capacity and metabolic stress in subjects with iron-deficient anemia. *Am J Clin Nutr.* 1977;30:910-917.
9. McClung JP, Karl JP, Cable SJ, et al. Randomized, double-blind, placebocontrolled trial of iron supplementation in female soldiers during military training: effects on iron status, physical performance, and mood. *Am J Clin Nutr.* 2009;90(1):124-131.
10. Ekiz C, Agaoglu L, Karakas Z, et al. The effect of iron deficiency anemia on the function of the immune system. *The Hematology Journal.* 2005;5:579-583.
11. Wilson C, McClung JP, Karl JP, Brother MD. Iron Status of Military Personnel Deployed to Afghanistan. *Mil Med.* 2011;176(12):1421-1425.
12. Beutler E, West C. Hematologic differences between African-Americans and whites: the roles of iron deficiency and α-thalassemia on hemoglobin levels and mean corpuscular volume. *Blood.* 2005;106(2):740-745.
13. Johnson-Spear MA, Yip R. Hemoglobin difference between black and white women with comparable iron status: justification for race-specific anemia criteria. *Am J Clin Nutr.*1994;60:117-121.
14. Armed Forces Health Surveillance Center. Uterine Fibroids, Active Component Females, U.S. Armed Forces, 2001-2010. *MSMR.* 2012; 18(12): 10-13.
15. Karl JP , Lieberman HR , Cable SJ , Williams KW , et al. Randomized, double-blind, placebo-controlled trial of an iron-fortified food product in female soldiers during military training: relations between iron status, serum hepcidin, and inflammation. *Am J Clin Nutr.* 2010;92(1):93- 100.
16. Health AL, Skeaff CM, Williams S, et al. The role of blood loss and diet in the etiology of mild iron deficiency in premenopausal adult New Zealand women. *Public Health Nutr.* 2001;4(2):1997-1206.
17. Harvey, LJ, Armah CN, Dainty JR, et al. Impact of menstrual blood loss and diet on iron deficiency among women in the UK. *Br J Nutr.* 2005;94(4):557-564.
18. King N, Fridlund KE, Askew EW. Nutrition issues of military women. *J Am Coll Nutri.* 1993;12:344-348.
19. Aymard JP, Aymard B, Netter P, et al. Hematological adverse effects of histamine H<sub>2</sub>-receptor agonists. *Med Toxicol Adverse Drug Exp.* 1988;3(6): 430-448.
20. Sarzynski E, Puttarajappa C, Xie Y, et al. Association between proton pump inhibitor use and anemia: a retrospective cohort study. *Dig Dis Sci.* 2011; 56(8):2349-2353.